Prediction of flow discharge in rivers in a context of climate changes: application of advanced monitoring and simulation techniques

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River flow monitoring

Concept

Rivers are dynamic systems that play a vital role in the hydrological cycle. River monitoring is essential for many goals like understanding long-term changes in river ecosystems, managing water resources, assessing pollution, predicting natural disasters such as floods. The reliable estimation of flow discharge and sediment transport is essential for understanding and managing river systems, particularly during extreme hydrological events. In recent decades, significant advancements have been made in methodologies, instruments, and software dedicated to the estimation of river discharge and sediment transport. These advancements have significantly enhanced our ability to collect and analyse data, which is important to improve predictions and decision-making. However, challenges remain, including the need of models' validation, calibration procedures, and uncertainty analysis integration. In this context, this PhD research project aims to identify advanced monitoring technologies and apply simulation softwares to estimate river discharge and sediment transport, particularly during flood events.

Scientific approach

River discharge measurement methods range from traditional to advanced. Acoustic Doppler Current Profilers (ADCP) method measures flow velocities by analyzing Doppler shifts, providing vertical velocity profiles. Despite advantages, ADCP faces challenges like boundary interference and turbulent flows. The first aim of the present research project is to define procedures improving the use of ADCP to estimate not only the flow velocity distribution but also other parameters such as suspended and bed loads. Furthermore, ADCP data will be used to calibrate other measurement techniques such as those based on image-analysis. The second aim of the present research project emphasizes the importance of numerical simulation in understanding and managing river flow processes. Calibration and validation of models are crucial, involving iterative adjustments to match observed data and ensuring predictive models' accuracy. In particular, the research activities will focus on using OpenFOAM and Ansys Fluent codes for river flow modeling, highlighting their capabilities and validating them by using real data.

Research objectives

Research objectives are:

1.Using ADCP measurements in rivers for understanding flow dynamics. Emphasis will be placed on factors affecting measurement accuracy, defining advanced data processing or machine learning techniques. Plans include implementing flow measures in different river sections, establishing a permanent monitoring system with high-resolution cameras, and using image processing for flow velocity estimation.

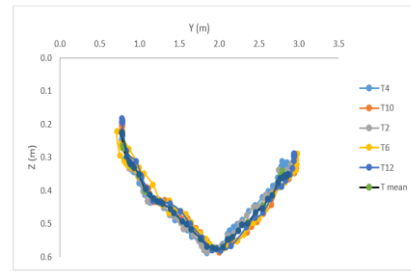
2. Applying OpenFOAM and Ansys Fluent codes for estimating river discharge and sediment transport with models' validation procedure by using real data.

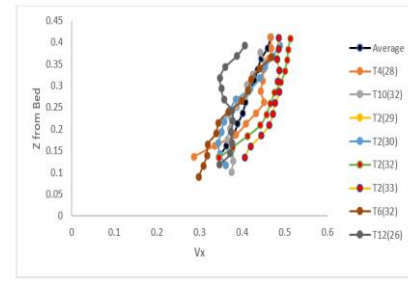
Research activities

Study area

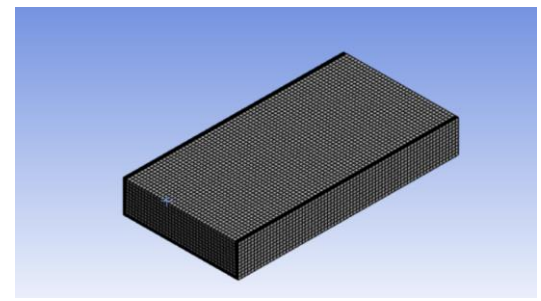
ADCP measurement

Data analysis





Meshing in numerical simulation



Non-uniform bed roughness